The embodiments of the invention in which an exclusive property or privilege is claimed is defined as follows:

Rule 1.126 ✓ 15

1. Injection molding apparatus comprising a nozzle (10) with a heater (32), an inner portion (12) having a melt bore (18) extending therethrough, and a tip insert (44) metalurgically bonded to the front end (16) of the inner portion (12).

Rule E2 ✓ 16

2. Injection molding apparatus as claimed in claim 1 wherein the tip insert (44) is brazed to the front end(16) of the inner portion (12),

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3. Injection molding apparatus as claimed in claim 2 wherein the heater is an electrical heating element (32).

Rule E3 ✓ 18

4. Injection molding apparatus as claimed in claim 3 wherein the heating element (32) is integrally brazed into a spiral groove (34) extending around the outer surface (22) of the inner portion (12).

Rule E1 ✓ 19

5. Injection molding apparatus as claimed in claim 4 where the electrical heater is brazed using a first material (76) and the tip insert (44) is brazed using a second material (82) and having a lower melting temperature than the said first material (76).

6. 20 Injection molding apparatus as claimed in claim 2 wherein the tip insert (44) has at least one tapered front tip (54).

7. 21 Injection molding apparatus as claimed in claim 6 wherein the at least one tapered front tip (54) extends diagonally outward.

8. 22 Injection molding apparatus comprising a nozzle (10) with a heater (32), an inner portion (12) having a melt bore (18) extending therethrough, a collar portion (20) metalurgically bonded ~~to the inner portion~~ to the inner portion (12) using a first material (76), and a tip insert (44) metalurgically bonded to the inner portion (12) using a second material (82).

Dub E5 9. 23 Injection molding apparatus as claimed in claim 8 wherein the collar portion (20) and the tip insert (44) are brazed to the inner portion (12).

Dub E4 10. 24 Injection molding apparatus as claimed in claim 9 wherein the second material (82) has a lower melting temperature than the first material (76).

11. 25 Injection molding apparatus as claimed in claim 10 wherein the heater is an electrical heating element (32).

Dub E6 12. 26 Injection molding apparatus as claimed in claim 11 wherein the heating element (32) is integrally brazed in a

spiral groove (34) extending around the outer surface 922) of the inner portion (12).

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13. A method of making an injection molding nozzle (10) with a heater (32) comprising making an inner portion (12) with a melt bore (18) extending therethrough and metalurgically bonding a tip insert (44) to the front end (16) of the inner portion (12).

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14. A method of making an injection molding nozzle (10) as claimed in claim 13 including brazing the tip insert (44) to the front end (16) of the inner portion (12).

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15. A method of making an injection molding nozzle (10) as claimed in claim 14 wherein the brazing is carried out at a relatively low temperature.

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16. A method of making an injection molding nozzle (10) as claimed in claim 14 wherein the tip insert (44) has at least one tapered front tip (54).

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17. A method of making an injection molding nozzle (10) as claimed in claim 16 wherein the at least one tapered front tip (54) extends diagonally outward.

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18. A method of making an injection molding nozzle (10) with a heater (32) and a melt bore (18) extending therethrough comprising metalurgically bonding an inner portion (12) and a collar portion (20) together at a first temperature, and metalurgically bonding a tip insert (44) to

the front end (16) of the inner portion (12) at a second temperature.

~~19~~ 33. A method of making an injection molding nozzle (10) as claimed in claim 19 including brazing the inner portion (12), collar portion (20) and tip insert (44) together.

~~20~~ 34. A method of making an injection molding nozzle (10) as claimed in claim 20 wherein the second temperature is lower than the first temperature.

~~21~~ 35. In a method of making an integral heated injection molding nozzle (10) comprising the steps of:

(a) making an elongated inner portion (12) having a rear end (14), a front end (16), a melt bore (18) extending therethrough from the rear end (14) to the front end (16), and a general cylindrical outer surface (22),

(b) making an outer collar portion (20) to fit around the inner portion (12) adjacent the rear end (14) of the inner portion (12), the outer collar portion (20) having a radial opening (42) therethrough,

(c) winding an electrical heating element (32) around the outer surface (22) of the inner portion (12), mounting the outer collar portion (20) in place around the inner portion (12) with at least one terminal portion (36) of the heating element (32) extending outwardly through the radial opening (42)through the outer collar portion (20),

and closing in the radial opening (42) around the at least one terminal portion (30),

(d) applying a first brazing material (76) having a predetermined melting temperature between the inner portion (12) and the surrounding outer collar portion (20), and

(e) integrally brazing the inner portion (12) and the outer collar portion (20) together by heating them in a furnace to a temperature above the melting temperature of the first brazing material (76), the improvement comprising the further steps of:

(f) making a seat (46) extending around the melt bore (18) at the front end (16) of the inner portion (12) of the nozzle,

(g) inserting a tip insert (44) into the matching seat (46) at the front end (16) of the inner portion (12) of the nozzle (10), the tip insert (44) having a rear end (57), a rear portion (48) extending forwardly from the rear end (57), at least one tip portion (50) extending forwardly from the rear portion (48), and a melt bore (56) extending forwardly therethrough from the rear end (57), the rear portion (48) being made to fit in the seat (46) at the front end (16) of the inner portion (12) of the nozzle (10) with the melt bore (18) through the tip insert (44) extending from the melt bore (18)through the inner portion (12) of the nozzle (10),

(h) applying a second brazing material (82) where the tip insert (44) and the inner portion (12) of the nozzle (10) join, the second brazing material

(82) having a predetermined melting temperature substantially lower than the melting temperature of the first brazing material (76), and

(i) integrally brazing the tip insert (44) in place in the inner portion (12) by heating them to a temperature above the melting temperature of the second brazing material (82) and below the melting temperature of the first brazing material (76).

22. A method of making an integral heated injection molding nozzle (10) as claimed in claim 4 wherein step (k) comprises heating in a substantially oxygen free atmosphere in a vacuum furnace (80).

23. A method of making an integral heated injection molding nozzle (10) as claimed in claim 23 including making the seat (46) around the melt bore (18) at the front end (16) of the inner portion of the nozzle cylindrical and also making the rear portion (12) of the tip insert (44) cylindrical to fit in said cylindrical seat (46).

24. A method of making an integral heated injection molding nozzle (10) as claimed in claim 24 including making the cylindrical seat (46) around the melt bore (18) at the front end (16) of the inner portion (12) of the nozzle (10) by machining.

25. A method of making an integral heated injection molding nozzle (10) as claimed in claim 24 further including the steps of:

(l) making a locating and sealing ring stopper sleeve (62) having a cylindrical inner surface (68) and a forwardly facing outer shoulder (66), the inner surface (68) being made to fit over the front end (16) of the inner portion (12) of the nozzle (10), and

(m) mounting the locating and sealing ring stopper sleeve (62) on the inner portion (16) of the nozzle (10) with the sealing ring stopper sleeve (62) adjacent the front end (16) of the inner portion (12) of the nozzle (10) before step (e), whereby step (e) integrally brazes the locating and sealing ring stopper sleeve (62) around the inner portion (16) of the nozzle (10).

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~~26~~. A method of making an integral heated injection molding nozzle (10) as claimed in claim 26 wherein closing in the radial opening (42) through the outer collar portion (20) around the at least one terminal portion (36) of the electrical heating element (32) comprises making the outer collar portion (20) with the radial opening (42) therethrough being a slot (42) and inserting into said slot (42) a terminal locating and sealing key (40) with at least one hole (38) therethrough to receive the at least one terminal portion (36) therethrough before step (d), whereby step (e) integrally brazes the terminal locating and sealing key (40) in said slot (42).

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27. A method of making an integral heated injection molding nozzle (10) as claimed in claim 27 wherein the first brazing material (76) is a nickel alloy.

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28. A method of making an integral heated injection molding nozzle (10) as claimed in claim 27 wherein the second brazing material (82) is a silver alloy.

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30. A method of making an integral heated injection molding nozzle (10) as claimed in claim 29 including making the tip insert (44) of a tungsten carbide alloy.

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31. A method of making an integral heated injection molding nozzle (10) as claimed in claim 22 wherein step (h) comprises making the tip insert (44) with one tip portion (50) having a conical outer surface (52) extending centrally forward from the rear portion (48), with the melt bore (56) extending therethrough having a central rear portion (58) and a front portion (60) extending diagonally outward from the central rear portion (58) to the conical outer surface (52).

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31. A method of making an integral heated injection molding nozzle (10) as claimed in claim 22 including making a bore between the tip insert (44) and the matching seat at the front end (16) of the inner portion (12) of the nozzle (10) and inserting a locating pin (84) into said bore to accurately orienting the tip insert (44) relative to the inner portion (12) of the nozzle (10) to allow the tip portion of the nozzle (10) to be accurately oriented with a gate.

46

32. A method of making an integral heated injection molding nozzle (10) as claimed in claim 32 wherein step (h)

comprises making the tip insert (44) with one tip portion (50) having a conical outer surface (52) extending diagonally outward from the rear portion (48), with the melt bore (56) extending centrally therethrough.

33. A method of making an integral heated injection molding nozzle (10) as claimed in claim 32 wherein step (h) comprises making the tip insert (44) with a pair of tip portions (50) having conical outer surfaces (57) extending diagonally outward from the rear portion (48), with the melt bore (56) extending centrally therethrough.

34. A method of making an integral heated injection molding nozzle (10) as claimed in claim 32 wherein step (h) comprises making the tip insert (44) with four tip portions (50) having conical outer surfaces (52) extending diagonally outward from the rear portion (48) with the melt bore (56) extending centrally therethrough.